Performance of Structural Concrete using Recycled Plastics Coated Aggregate as Coarse Aggregate

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Abstract- One of the main environmental hazards today is the disposal of waste plastics, that is menacing to the landfill. Similarly the construction industries are facing problem due to the inadequate and unavailability of construction materials. The Bhubaneswar Municipal Corporation, Odisha alone generates approximately 540 MT of solid waste per day (TPD). Assuming 6 to 7% is the plastic waste from the total Solid Waste generated in Bhubaneswar alone, the city hence is generating 34 to 38 MT plastic wastes per day. Above this 2% of solid e-waste is generated. It has been observed that disposal of plastic waste may be a serious concern thanks to improper collection and segregation system. However, a couple of technologies are developed to attenuate its adverse effect on the environment. Currently, Worldwide accepted technology used for the plastic disposal is incineration. That it causes release of toxic gases like chlorinated dioxins and furans which eventually cripple the environment hazards, the plastic waste can be used rather than incinerated. So we need to find new construction material as well as a capable method for disposal of plastic waste. The above mentioned two issues have overlapping solution. Hence M25 grade concrete was designed using plastic wastes (PET). M25 grade concrete test sample were casted to study the behavior with various proportions of PET from 0% to 20%. Plastic Bottles were collected from various sites and cut into small pieces. These small pieces which are 10% of coarse aggregate are melted in the furnace and mixed with clean and dry coarse aggregates. A second sample with 20% of coarse aggregate is also made. Then these plastic coated aggregates were cooled for at least 6 hour. Then test samples were casted with plastic coated aggregate. In another mix 10% and 20% plastic were used as a replacement of coarse aggregates. This enables a comparison of compressive strength and flexural strength for hardened concrete with replacement of plastic directly in fresh concrete and with plastic coated on aggregate.

Keywords – Watermarking, Haar Wavelet, DWT, PSNR

I. INTRODUCTION

The Indian housing industry is today consuming about 400 million plenty of concrete per annum and it's expected, that, this might reach a billion tones in but a decade. All the materials required to supply such huge quantities of concrete, come from the earth's crust, thus depleting its resources per annum creating ecological strains. On the opposite hand, human activities on earth produce solid wastes in Considerable quantities i.e., over 2500million tones per annum, including industrial waste, agricultural waste, and other wastes from society. Disposal of such solid wastes involves economic issues also as ecological and environmental considerations. The plastic is one of the recent engineering materials which have appeared in the market all over the world. Plastics are used in the bath and sink units, corrugated and plain sheets, floor tiles, paints, etc. Other than this domestically plastics are used in various forms as carrying bags, bottles, cans and in various medical utilities. Plastics are normally unstable and non-biodegradable. So, their disposal poses problems. Research works are happening making use of plastics wastes effectively as additives in bitumen mixes for the road pavements. Reengineered plastics are used for solving the solid waste management problems [1,13,14,19], a contribution to the effective use of domestic plastic waste in concrete to stop environmental strains caused by them. Plastics are used as replacement of fine aggregates [8,10,12,21], coarse aggregates [20,22] and as plastic fibres [9,18]. Using plastics as fibres, flexural strength increases [11,16,17]. It also enhances crack resistance [2,3,4,11] and hence durability [23].THE PLASTIC TO SEMI-PLASTIC CONCRETE REVEALED TO BE RESILIENT AND CAPABLE OF WITHSTANDING MULTIPLE LOADING AND CEASED LOADING CYCLES WITHOUT FAILURE, WHILE A SOLID BUT STILL WEAK CONCRETE COULD NOT WITHSTAND SUCH LOADING CYCLES [5]. THE ADDITION OF THE PLASTIC WASTE TYPE (PET) TO THE CEMENT MORTAR LEAD TO INCREASE THE MECHANICAL PROPERTIES OF THIS MORTAR [6,7]. WITH 25% TO 30% WASTE POLYETHYLENE HAVE GOOD WORKABILITY TO MAKE HOLES WITHOUT ANY PROBLEM. HOWEVER, WHEN THE PERCENTAGE OF WASTE DECREASE FROM 15% OR INCREASE FROM 30%, THE WORKABILITY WILL BE WEAK AND POWER WAS GENERATED DURING THE CUTTING OPERATION [15].

II. Material used in investigation

The materials used for making concrete specimens are Cement, Fine aggregate, Plastic coated course aggregate and water.

2.1 Cement (OPC): –

OPC 53 Grade cement is required to conform to BIS specification IS: 12269-1987 with a designed strength for 28 days being a minimum of 53 MPa or 530 kg/sqcm .Grade of cement OPC53 (RAMCO) packed by Jan 2019, specific gravity of cement 3.15& fineness of cement 3.8%.

2.2. Coarse Aggregates –

Coarse aggregate used in this study were 20-mm nominal size, and were tested as per Indian Standard Specifications IS 383-1970.

Coarse aggregates comprising a maximum size of 20mm having fineness modulus of 6.05, specific gravity of 2.65 , in saturated surface dry condition were used.

Fig 1: (A) Setting time of cement (B) Graded aggregates (C)Water absorption of aggregate

2.3. Fine Aggregate –

Fine aggregate are material passing through an IS sieve that is less than 4.75mm gauge beyond which they are known as coarse aggregate.

According to IS 383:1970 the fine aggregate is being classified in to four different zone, that's Zone-I, Zone-II, Zone-III, Zone-IV. Also just in case of coarse aggregate maximum 20 mm coarse aggregate is suitable for concrete work. Fine aggregates having a specific gravity of 2.58, in saturated surface dry condition were used.

2.4. Plastics used in investigation Plastic Bottle (Polyethylene terephthalate): –

Waste plastic bottles strewn across were collected and cut in small pieces.

These small pieces of plastics in 10%, 20% of coarse aggregate melted in furnace and mixed with clean and dry coarse aggregates. Then these plastic coated aggregates were cooled for at least 6 hour. Then concrete prepared with plastic coated aggregate and moulds are prepared for various tests. In another mix 10% and 20% plastic were used as a replacement of coarse aggregates. The comparison of strength is studied under various Loads. Firstly with 10% &20% replacement of concrete; Secondly with 10% &20% of plastic melted and thirdly without plastic M-25 grade concret.

Fig 2: (A) Shredded PET (B) Furnace (C) Coating of melted PET on aggregate (D) Plastic Coated Aggregate

2.5. Water –

Drinking water was used in concrete with 38% water cement ratio.

Table -1 Material Specification

Sl no.	Ingredient		Specifications.	Remark.
1	Cement(OPC 53 Grades) As per IS12267-1976		Sp.gravity 3.15	3.15
			Normal Consistency 32.5%	30%-35%
			Initial Setting time 37	>30
			Final Setting time 420	<600
			Fineness 3.8%	<10%
2	Coarse Aggregate.	Plane Aggregate	20mm size,Sp.gr.2.67 FM:6.05	Is-383-1970(9)
		Plastic Coated Aggregate	20mm size,Sp.gr.2.47 FM	

3	Fine aggregate.	River sand zone II Sp.gr.2.58	Is-383-1970(9)

IV. METHODOLOGY

3.1. Compressive Strength –

For compressive strength test of cube samples, cube specimen of 150 x 150x150 mm as per IS 516:1999 were casted for M25 grade concrete. M25 grade concrete test sample were casted to study the behavior with various proportions of PET from 0% to 20%. Plastic Bottles were collected from various sites and cut into small pieces. These small pieces which are 10% of coarse aggregate are melted in the furnace and mixed with clean and dry coarse aggregates. A second sample with 20% of coarse aggregate is also made. Then these plastic coated aggregates were cooled for at least 6 hour. Then test samples were casted with plastic coated aggregate. In another mix 10% and 20% plastic were used as a replacement of coarse aggregates. This enables a comparison of compressive strength for hardened concrete with replacement of plastic directly in fresh concrete and with plastic coated on aggregate.

The moulds were filled with designed concrete. After 24hrs the specimens were demoulded and were cured for 28 days. These specimens were tested in compression testing machine and their average reading value were noted.

Table -2 Compressive Strength

Sl. No.	% plastic Used.	7 days(Mpa)		28 days(Mpa)	
		Plastic coated aggregate	Plastic Fiber	Plastic coated aggregate	Plastic Fiber
1	0%	19.4	19.4	30.95	30.95
2	10%	28.14	21.38	31.54	27.10
3	20%	26.23	18.37	29.54	25.41

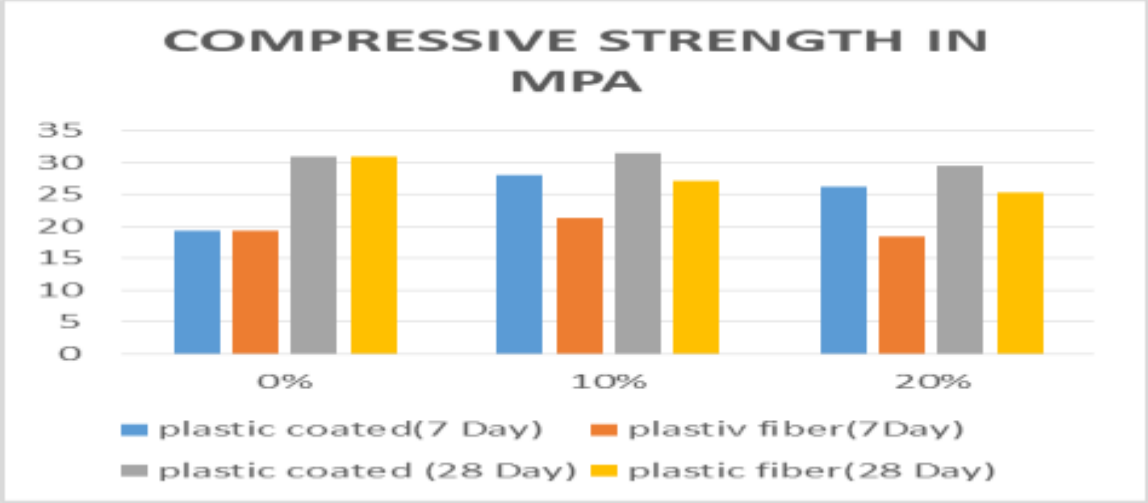

Fig 3: The compressive strength of concrete cubes after 7days and 28 days of curing

3.2. 3.2 Flexural Strength–

For Flexural strength test, three prism specimens of 500 x 100x100 mm were casted as per IS 516:1999 for M25 grade concrete. The moulds were filled with fiber concrete and plastic coated aggregate concrete. After 24hr the specimens were demoulded and were cured for 28 days. These specimens were tested in universal tesing machine and their average values were noted.

Table -2 Flexural Strength

Sl. No.	% plastic used	7days (Mpa)		28 days (Mpa)	
		Plastic coated aggregate	Plastic Fiber	Plastic coated aggregate	Plastic Fiber
1	0%	3.19	3.16	3.88	3.93
2	10%	3.81	3.31	3.99	3.81
2	20%	3.62	3.08	3.90	4.25

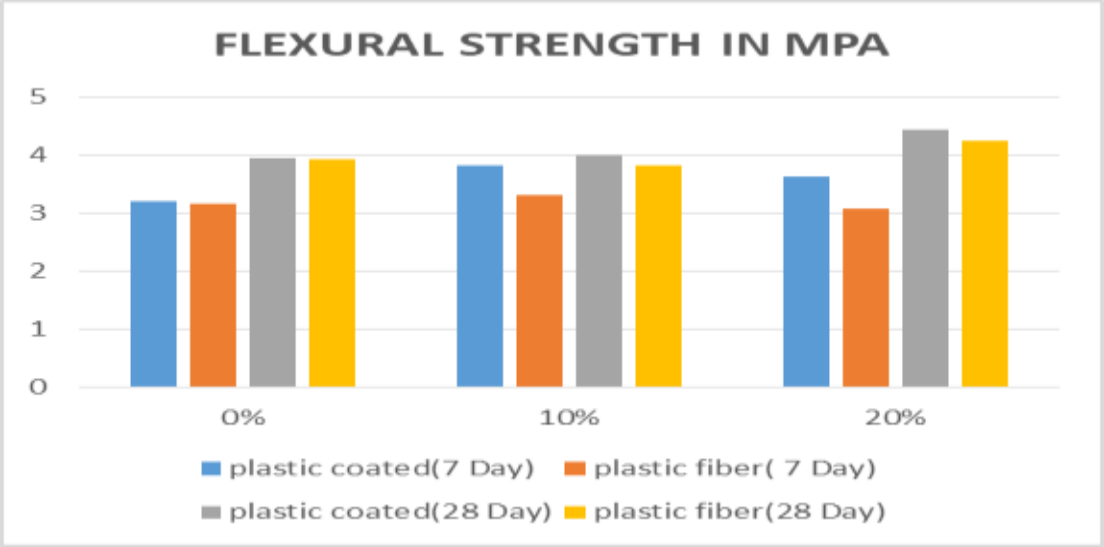

FIG 4: THE FLEXURAL STRENGTH OF CONCRETE CUBES AFTER 7DAYS AND 28DAYS OF CURING

V.CONCLUSION

From the above experimental work, it was concluded that plastic waste (PET) can be used as partial replacement of natural aggregate or plastic coated aggregate,

From the result obtained from these experiments the following conclusion can be drawn.

1. The compressive strength increases with increase in plastic aggregates up to 20 Percentage.
2. The compressive strength of concrete with plastic coated aggregate is more as compared to concrete with partly replaced plastic aggregate.
3. Use of plastic is an ecofriendly approach.
4. Concrete with plastics also helps for solid waste management.
5. Preparation of light weight concrete with good strength can be done by using plastic in concrete.

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